Practice Level Costs of Office-Based Hypertension Performance Improvement: The Heart Healthy Lenoir Study

Jacqueline R. Halladay, MD, associate professor, Department of Family Medicine and Sheps Center for Health Services Research, University of North Carolina at Chapel Hill; Jim Tillman, DMin, health coach and trainer, Open Water Coaching and Consulting, Cape Carteret, North Carolina; Alan Hinderliter, MD, associate professor, Department of Medicine, University of North Carolina at Chapel Hill; Doyle M. Cummings, PharmD, professor, Department of Family Medicine, East Carolina University, Greenville, North Carolina; Katrina E. Donahue, MD, professor, Department of Family Medicine and Sheps Center for Health Services Research, University of North Carolina at Chapel Hill; Crystal Cene, MD, associate professor, Department of Medicine, University of North Carolina at Chapel Hill; Cassie Miller, Beverly Garcia, Alice Ammerman, DrPH, and Darren DeWalt, MD, professors, Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill; and the Heart Healthy Lenoir Research Team

EXECUTIVE SUMMARY

Primary care practice leaders who consider engaging in quality improvement (QI) need to understand the practice level costs incurred when asking staff to take on new tasks. The Heart Healthy Lenoir study is a prospective cohort trial in which QI methods were used to enhance hypertension (HTN) care and reduce racial disparities in blood pressure control in small rural primary care practices in North Carolina. As part of this effort, we performed an activity-based costing analysis to describe the costs incurred to develop, implement, and maintain key tasks.

We interviewed 20 practice stakeholders and phone-based health coaches during 2012–2014. We calculated the time invested by individuals to perform each task within each study phase and applied national hourly wages to generate cost estimates. Our descriptive analyses focus on four of the most widely used practices. Activities included time to abstract HTN control data, participate in project meetings, identify patients with uncontrolled HTN, create standardized work, and provide additional health coaching

For more information about the concepts in this article, contact Dr. Halladay at jacqueline_halladay@med.unc.edu.
The authors declare no conflicts of interest.

DOI: 10.1097/JHM-D-17-00010

for patients with uncontrolled HTN. Despite practice and staffing differences, the developmental phase costs were similar, ranging from $879 to $1,417. Implementation costs varied more widely as practices took different approaches to identifying patients with uncontrolled HTN. Practice-specific phone health coaching costs ranged from $19,508 to more than $38,000. This study adds to the growing literature regarding practice level costs of engaging in systems change. Understanding these costs and balancing them against practice incentives may be helpful as stakeholders make decisions regarding HTN QI.

INTRODUCTION

Nearly one third of U.S. adults have hypertension (HTN), increasing their risk for cardiovascular morbidity and mortality (National Center for Health Statistics, 2013). The costs of HTN in the United States have been estimated to be $93.5 billion, including costs of healthcare services, medications, and missed work days (Heidenreich et al., 2011). Patients who adhere to therapeutic regimens can reduce their cardiovascular-related risk (Estruch et al., 2006, 2013; Keyserling et al., 2014) and use of hospitals and emergency departments, thus positively affecting lives and better controlling these healthcare costs (Pittman, Tao, Chen, & Stettin, 2010). Identifying feasible and fiscally sound interventions to improve blood pressure (BP) control is a key objective for patients, physicians, and payers (Barton, Andronis, Briggs, McPherson, & Capewell, 2011; Keyserling et al., 2014; Kilpatrick et al., 2005) and may be of heightened importance in communities and medical practices with limited financial resources.

As primary care practices shift their focus toward managing patient populations and ongoing performance improvement, data-driven quality improvement (QI) approaches to optimize BP control are attractive options to help guide the change process. Practice leaders can review the practice-based QI activities that are effective in improving BP metrics and adapt relevant strategies for their unique settings (Mueller, Purnell, Mensah, & Cooper, 2015; Shojania, McDonald, Wachter, & Owens, 2004; Walsh et al., 2006). However, providers and practice administrators also need to understand the costs their practices may incur in taking on these new endeavors.

A limited number of publications describe the costs incurred by practices to implement practice improvement activities. Some authors calculate societal level costs, including patient, health system, and nonmedical costs (Allen, Dennison Himmelfarb, Szanton, & Frick, 2014; Brunenberg et al., 2007; Chung et al., 2014; Reed et al., 2010), whereas others describe practice level costs to finance individual programs such as a self-management support program (Hollenback, Weiner, & Turner, 2014; Schroeder, Fahey, Hollinghurst, & Peters, 2005).

With this article, we add to the growing literature by detailing the practice level costs of participating in the National Heart, Lung, and Blood Institute-funded Heart Healthy Lenoir (HHL) HTN multilevel intervention cohort trial that took place in an economically distressed and rural region of North Carolina from 2010 to 2015 (North Carolina Department of Commerce, 2015). As part of the larger

study, we performed an activity-based costing analysis for each of the four most engaged practices. We present information about how we engaged with various stakeholders to develop and implement the HHL intervention and describe the practice level costs incurred to cover staff time to perform key tasks.

Our objectives are twofold: (a) to describe the cost estimates such that primary care practice stakeholders have insights into potential expenses incurred when investing staff time and other resources in HTN QI initiatives and (b) to gain insights into the nature of the key QI tasks staff members may need to perform.

METHODS

Setting

The HHL study is a practice-based multilevel QI effort designed to improve HTN control and to narrow racial disparities in HTN control in rural North Carolina. We focused on this region because of the elevated rates of HTN, cardiovascular morbidity and mortality, noted racial disparities in HTN prevalence, relative economic distress, and existing collaborative community and healthcare infrastructure. Six primary care practices without experience in HTN QI work participated in the trial.

Development of the HHL QI Intervention

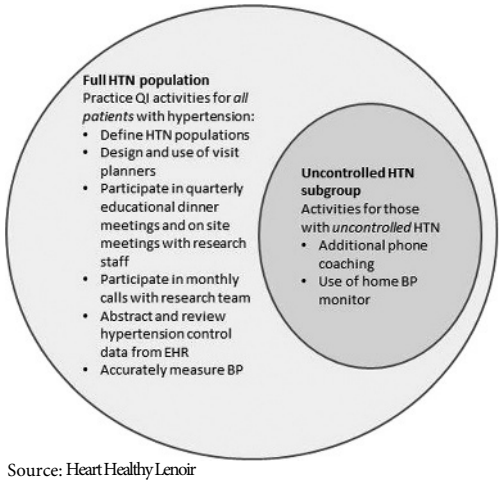
We engaged with practice stakeholders and patients to develop the QI intervention. Our approach is based on our team's extensive experience in developing QI methods, processes, and tools (DeWalt et al., 2004; Donahue, Halladay, et al., 2013; Donahue, Newton, Lefebvre, & Plescia, 2013; Finkelstein, Khavjou, & Will, 2006; Finkelstein, Wittenborn, & Farris, 2004; Halladay et al., 2014; Rothman et al., 2005) and in creating a practice change model to guide change (Margolis et al., 2010). The key driver model, rooted in the Chronic Care Model (Bodenheimer, Wagner, & Grumbach, 2002; Wagner, Austin, & Von Korff, 1996), includes defining and tracking a patient population of focus, standardizing care delivery using planned care templates, using and tailoring evidence-based guidelines to organize care such that it is locally relevant, and implementing patient self-management support systems.

We engaged with various practice staff members at regional quarterly dinner meetings, on-site practice meetings, and via monthly conference calls to discuss the evidence-based strategies that could be tested and tailored to meet the needs of the regional practices and patients. The agreed-upon activities were implemented throughout the course of the study, thus providing opportunities for experiential learning and team-based problem solving. We adapted our phone coaching program content and counseling frequency from the work of Bosworth and colleagues (Bosworth et al., 2005; Reed et al., 2010). The key study tasks developed collaboratively are shown in Figure 1 and Tables 1–3 and are explained here.

Final HHL QI Intervention: A Two-Level Intervention

Figure 1 lists the main activities developed and implemented for all patients with HTN (full HTN population), and those additional activities provided for a nested cohort of patients with uncontrolled HTN (uncontrolled HTN group). We used a systolic BP of ≥140 or a diastolic BP of ≥90 mm Hg to define the population with uncontrolled HTN.

FIGURE 1
Practice- and Patient-Level Interventions in the Heart Healthy Lenoir Study



Source: Heart Healthy Lenoir

For the full HTN population work in practices, we devised and implemented a visit planner—a standardized document with key questions, educational content, and concerns to address with each HTN patient at every visit (visit www.heart healthylenoir.com/practices). These activities included processes to consistently address adherence to medication regimens, use of teach-back techniques, help to enable patients to understand the chronic nature and downstream consequences of HTN, and encouragement to use home blood pressure monitoring (HBPM). We also encouraged providers to consider using HBPM data in clinical decision-making. We provided on-site instruction in measuring BP accurately and assisted practice informatics technology staff in understanding how to abstract and review HTN control performance data overall, by race, and by ethnicity. We guided practices in learning how to use their performance data to make small changes in workflows.

Patients included in the nested, uncontrolled HTN cohort were given a home BP monitoring unit and referred to a phone-based health coach who provided a structured and targeted educational curriculum. We worked with providers and staff to create a coaching call summary form that was reviewed after each coaching session. Further details of the HHL study are described in the study protocol report (Halladay et al., 2013).

Practices Included

We limited the HHL cost analyses to the four most engaged practices and focused on activities listed in Tables 1–3. One of the four practices did not readily engage after the first year, but we included it in our cost analysis for the work it completed.

Cost Data Collection Sources

Over a 15-month period from 2012 to 2014, we held face-to-face or phone-based semistructured interviews with 20 staff members who worked in one of the four cost study practices to collect time estimates for study tasks. We recorded attendance for each group activity from 2010 to 2014. For repeated group activities, such as attending regional dinner meetings, we conferred with each practice's lead provider or administrator to generate a minimum number of staff needed to attend each meeting, such that actual practice changes occurred. We used this minimum staff attendance in our cost calculations. We also interviewed the two regional health coaches to gain an understanding of the time invested in arranging and conducting the telephone calls with patients.

To calculate the number of patients in each practice who met the definition of uncontrolled HTN, and thus were theoretically able to receive additional self-management support via phone-based

TABLE 1

Practice Level Staff Costs[a] and Staffing Models Used Among Four Most Engaged Heart Healthy Lenoir Practices: Developmental Phase Tasks

Developmental Phase, Year 1, Time Costs Only

	Total Cost of Each Task (No. of Practice Staff per Task[b])			
	Practice 1	**Practice 2**	**Practice 3**	**Practice 4**
Task 1. Initial generation of lists of patients with HTN and uncontrolled HTN, by race and ethnicity	$382 (2)	$910 (1)	$1,074 (2)	$910 (1)
Task 2. 1 hour on-site practice provider-staff meeting to design and tailor intervention	$306 (10)	$188 (5)	$171 (4)	$139 (5)
Task 3. On-site instruction in accurate blood pressure measurement	$191 (11)	$214 (7)	$172 (4)	$234 (7)
Total costs	**$879**	**$1,312**	**$1,417**	**$1,283**

Staffing Models Used for Each Task

Task 1.
- Practice 1: Informatics staff (1 off-site informatics staff and 1 on-site administrator with informatics skills)
- Practice 2: Informatics staff (trained administrator)
- Practice 3: Informatics staff (1 off-site informatics staff member and 1 on-site administrator with informatics skills)
- Practice 4: Informatics staff (trained administrator)

Task 2.
- Practice 1: 1 PM, 1 NP, 1 MD, 1 RN, 2 LPNs, 2 MAs, 2 office support staff
- Practice 2: 1 NP, 1 RN, 1 lab/technologist, 1 MA, 1 office support staff
- Practice 3: 1 MD, 1 PA, 1 office manager, 1 office support staff
- Practice 4: 1 MD, 2 MAs, 2 office support staff

Task 3.
- Practice 1: 1 NMW, 6 CMAs, 1 LPN, 3 MAs
- Practice 2: 1 NP, 1 RN, 1 technician, 1 MA, 1 CNA, 1 MD
- Practice 3: 1 MD, 1 PA, 1 office manager, 1 CMA
- Practice 4: 1 MD, 1 NP, 3 MAs, 2 RNs

Note. HTN = hypertension; PM = practice manager; NP = nurse practitioner; MD = medical doctor; RN = registered nurse; LPN = licensed practical nurse; MA = medical assistant; NMW = nurse midwife; CMA = certified medical assistant; CNA = certified nursing assistant; PA = physician assistant.

[a]All costs were generated using 2010 mean salaries (without benefits) of key practice staff required for each activity.

[b]The number of staff required for each activity is based on the actual experience of the practice and research team consensus.

health coaching and HBPM, we used the data from each practice's first reliable population level HTN control performance report. This report was the first in which the practice leadership agreed that the numbers of patients with HTN and with uncontrolled HTN were correct. In our analyses, we elected to base our coaching costs estimate on this actual number of patients with uncontrolled HTN per practice, because this estimate better reflects the number of patients in need of additional self-management support services outside of the research context (where study inclusion also relied on agreeing to be a study participant).

TABLE 2

Practice Level Staff Costs[a] and Staffing Models Used Among Four Most Engaged Heart Healthy Lenoir Practices: Implementation Phase Tasks

First Year of Implementation

	Total Cost of Each Task (No. of Practice Staff per Task[b])			
	Practice 1	**Practice 2**	**Practice 3**	**Practice 4**
Task 4. Hypertension control rates/performance data abstractions: monthly (all patients seen in a month) and yearly (unique patients' yearly data pulled every 6 months) by informatics staff	$346 (2)	$218 (1)	$182 (2)	$218 (1)
Task 5. Practice staff attendance at 4 quarterly dinner meetings per year[a]	$2,449 (10)	$1,702 (5)	n/a	$1,001 (4)
Task 6. Participation staff in four separate 1-hour on-site coaching visits[a]	$1,225 (10)	$851 (5)	n/a	$500 (4)
Task 7. Participation in 10 monthly calls by lead provider and/or administrator	$,1361 (2)	$419 (1)	n/a	$836 (1)
Total costs	**$5,381**	**$3,190**	n/a	**$3,027**
Task 8. Special cost in first year of implementation phase required to identify patients at the point of care with uncontrolled HTN, as EHR abstractions performed by information technology staff underestimated this population	$1,450 (4)	$5,907 (1)	n/a	$472 (1)
Total costs in year 1 of implementation	**$6,831**	**$9,097**	**n/a[b]**	**$3,499**

Staffing Models Used for Each Task

Task 4. All practices: Same informatics staff as listed in Table 1, Task 1

Task 5. Quarterly meetings (estimate of average number of attendees per meeting):
- Practice 1: 1 PM, 1 NP, 1 MD, 1 RN, 2 LPNs, 2 MAs, 2 administrative support staff
- Practice 2: 1 NP, 1 RN, 1 MA, 1 lab technologist, 1 office support staff
- Practice 3: n/a
- Practice 4: 1 MD, 1 MA, 2 office support staff

Task 6. On-site coaching visits (estimates of average attendance):
- Practice 1: 1 PM, 1 NP,1 MD,1 RN, 2 LPNs, 2 MAs, 2 administrative support staff members
- Practice 2: 1 NP, 1 RN, 1 MA, 1 laboratory technologist, 1 office support staff member
- Practice 3: n/a
- Practice 4: 1 MD, 1 MA, 2 office support staff members

Task 7. Monthly design team calls:
- Practice 1: 1 MD, 1 PM
- Practice 2: 1 NP
- Practice 3: n/a
- Practice 4: 1 MD

Continued on next page

TABLE 2 *(Continued)*

First Year of Implementation
Staffing Models Used for Each Task
Task 8. Special costs to identify patients with uncontrolled HTN:
Practice 1: LPN (1 minute to identify each of 200 patients) and providers (20 minutes per week for 6 months to review lists for acceptability)
Practice 2: Office manager faxed visit lists and entered BP on these lists for study staff members who reached out to patients with uncontrolled HTN (1.5 hours per day for 5 months, then 30 minutes per day for 7 months)
Practice 3: n/a
Practice 4: Medical assistant scanned BP for 15 minutes per day to find eligible patients to refer to research staff

Note. n/a = not available; HTN = hypertension; EHR = electronic health record; PM = practice manager; NP = nurse practitioner; MD = medical doctor; RN = registered nurse; LPN = licensed practical nurse; MA = medical assistant; BP = blood pressure.

[a]The number of staff members required for each activity is based on the actual experience of the practice and research team consensus, where repetitive activities occurred with slight variations in practice staff attendance.

[b]Total cost data not available for the practice.

TABLE 3

Staff and Coaching Costs for Phone Coaching Services for Patients with Uncontrolled Hypertension and Cost Estimates to Provide Services for Future Incident Cases

Costs for Phone Coaching Services by Task					Cost per New Patient[a] Incident Cases During Maintenance Period
	Practice 1 (*n* = 871)	Practice 2 (*n* = 660)	Practice 3 (*n* = 445)	Practice 4 (*n* = 177)	
Task 9. MD/NP/PA time to review coaching report summaries based on no. of patients with uncontrolled HTN	$9,964	$5,518	$3,952	$1,480	$12
Task 10. MA time to process coaching summary reports for provider review and signature	$3,345	$2,534	$1,708	$680	$4
Total practice staff costs	**$13,309**	**$8,052**	**$5,660**	**$2,160**	**$16**
Task 11. Cost per hour for vendor-sponsored phone coaching services (phone coach)	$30,311	$22,968	$15,486	$6,160	$35
Task 12. Cost per hour for vendor-sponsored phone coaching services (administrative support for phone coach)	$8,013	$6,072	$4,094	$1,628	$9
Total health coaching costs	**$38,324**	**$29,040**	**$19,508**	**$22,407**	**$44**

Note. MD = medical doctor; NP = nurse practitioner; PA = physician assistant; MA = medical assistant.

[a]The authors created a primary care provider salary based on an average of hourly salaries of family medicine and internal medicine providers using the 2010 U.S. Bureau of Labor Statistics data.

Cost Categories

We categorized the cost estimates according to whether the activities were one-time developmental activities, part of the study implementation, or estimated to be required to sustain this work in a maintenance phase. These activities are described here and shown in Tables 1–3.

Table 1 describes the one-time development phase costs and staffing models used by each practice to complete each task. Table 2 lists the implementation phase tasks, costs, and staffing models used to support recurring work needed to identify hypertensive patients, participate in on-site and regional dinner meetings (Tasks 5–8), and abstract and review HTN performance data (Task 4). Unfortunately, several of the initial electronic health record (EHR) data pulls greatly underestimated the number of patients with uncontrolled HTN; thus, additional work by staff was needed at the point of care to identify eligible subjects. This additional case-finding task was required only in the first year of implementation (Table 2, Task 8).

We also estimated the costs to sustain QI activities and manage future incident cases of uncontrolled HTN (i.e., maintenance phase costs). As part of this future-casting work, we include a per-incident case estimate for the phone coaching services in Table 3. This is the only place where we describe our cost estimates at a per-patient level.

Calculating Costs

Practice Staff Member Costs by Task and Study Phase

We determined the total costs of each task by multiplying hourly salaries of those involved in each task by the number of minutes spent on each activity and then summed these individual staff costs to calculate the total cost of each activity. We used 2010 U.S. mean hourly salaries where available (U.S. Bureau of Labor Statistics, 2010; Table 4). We did not include benefits in our calculations, because we lacked information about benefits structures and the full- or part-time status of interviewees. Given that activities could be performed by personnel with differing hourly wages (e.g., a nurse practitioner in one practice may have performed the same activity as a physician in another practice), we display the total costs per practice and list the staffing models involved by task (Tables 1 and 2). We also summed these task costs for the three study phases.

Phone Coaching Cost Estimates—Full Population With Uncontrolled HTN

As described earlier, we used the first reliable population level HTN performance report in each practice to calculate the cost to provide phone coaching services to patients with uncontrolled HTN.

As phone coaching services in the state are currently offered as vendor services, we calculated the cost to offer time-based vendor services to support patients. Other than the administrative time needed to arrange telephone calls with patients, we did not attempt to include the actual service provider's infrastructure costs. For our cost calculations, we used a yearly salary of $36,000 for a phone coach, because this category was not listed in the 2010 national compensation survey (U.S. Bureau of Labor Statistics, 2010). We also included the costs of having providers and staff members review the coaching visit summaries. For this estimate, we averaged the hourly salaries of internists and family medicine providers to generate the primary care provider hourly salary.

TABLE 4
Acronyms, Titles, and Salaries in 2010

Acronym or Title	Role	U.S. Hourly Wage ($) as of May 2010[a]
Administrative support	Office manager	24.41
	Office and administrative support workers	
	Other (first-line supervisors of office and administrative support workers)	
Health coach	Health coaches	17.31[b]
Informatics	Database administrators	36.41
LPN	Licensed practical and licensed vocational nurses	19.88
MD	Internists, general	91.10
MD	Family and general practitioners	83.59
MA, CMA, CNA	Medical assistant	14.31
	Certified medical assistant	
	Certified nursing assistant	
Office support	Billing staff, general office staff	13.58
PA, NP, NMW	Physician assistants	41.89
	Nurse practitioners	
	Nurse midwives	
PM	Practice managers	45.03
	Medical and health services managers	
RN	Registered nurses	32.56
Technologist	X-ray radiologic technologists and technicians	26.80

[a]*Source*: U.S. Bureau of Labor Statistics (2010).
[b]Estimated costs due to lack of role and salary data in the 2010 resource.

Costs of HBPMs

The HBPM units purchased for the study cost $58.70 each. Because this expense is generally the patient's, we did not include this cost in the practice level analyses. However, the total costs for these devices, if applied to each practice's total population with uncontrolled HTN, were $51,128 for Practice 1, $38,742 for Practice 2, $26,122 for Practice 3, and $10, 390 for Practice 4.

RESULTS

Study practice demographics are described in Table 5. All practices in the study are in rural North Carolina and serve patients in a two-county area. Collectively, these practices serve many patients from lower socioeconomic levels and a high number of African Americans.

The costs of tasks in each phase are shown in Tables 1–3. Of note, we did not specify in the staffing model footnotes whether the primary care providers were family medicine or internal medicine providers, but we did include the salary differences in our calculations.

Practice 1

This practice is a community health center (CHC) with three main providers who saw patients with HTN as part of the study. This practice had invested in informatics systems before this study as part of other statewide QI efforts in diabetes and asthma treatment. This infrastructure and experience were important for providing more efficient methods to abstract electronic health data. Completion of Task 1

in the developmental phase was performed by a dyad of an off-site informatics staff person and an on-site practice administrator. The estimated $382 for this one-time activity included the work of these two employees who collectively spent 10.5 hours on this task. In contrast, less experienced informatics teams from the other practices required 25–29.5 hours to complete this task, which is key to understanding the difference in costs for Task 1. Practice 1 dedicated 9.5 hours per year to continue pulling monthly and yearly performance data during the study's implementation phase.

Total costs to cover staff time to participate in the study-related on-site practice visits and dinner meetings during the implementation phase were slightly more than $5,000 per year. Staff members attending these sessions included primary care providers, practice administrators, medical assistants, and office support staff. Two people, usually a lead practice administrator and one primary care provider, joined our monthly telephone calls at a cost of slightly more than $1,300 per year.

Estimated practice staff–associated phone coaching costs totaled just over $13,000 for time to review the coaching summaries for 871 patients with uncontrolled HTN; an additional $38,324 covered the coaching vendor's time.

Practice 2

This private practice is in a more rural region and provides care for a somewhat similar patient demographic as that in Practice 1. The most engaged staff person was a midlevel provider who attended the dinner meetings and participated in our monthly design team meetings. We should point out that Practices 2 and 4 shared some administrative resources, namely their lead informatics staff member, who learned how to abstract the HTN performance data for these practices that used the same EHRs. The greatest amount of time was spent doing the preliminary work to understand how to abstract reliable HTN control measures. Because unique but similar work was required to pull these data from the two practices, we assigned the required time investments to each

TABLE 5
Practice Demographics

Demographics	Practice 1	Practice 2	Practice 3	Practice 4
Type	CHC/FQHC	Private	CHC/FQHC	Private
Specialties	IM, Ped, FM	FM	FM, IM	FM
No. of full-time MDs/DOs	6[a]	1	1	1
No. of midlevel providers	2	1	2	1
Payer mix				
% Medicaid	21%	19%	25%	20%
% Self-pay	36%	15%	50%	9%
Approximate no. of patient visits per year	40,176[b]	10,200	9,600	9,600
Approximate no. of HTN patients seen per year	1,800	1,300	1,050	800

Note. Data for the cost study are from the four most engaged practices in the Heart Healthy Lenoir study.

Note. CHC = community health center; FQHC = federally qualified health center; IM = internal medicine; FM = family medicine; Ped = pediatrics; MD = medical doctor; DO = doctor of osteopathic medicine.

[a]Three providers at any one time saw adult patients as part of the Heart Healthy Lenoir study.

[b]Visits per year at the CHC include maternity, pediatric, and dental visits.

practice separately. During the implementation phase, the informatics specialist remarked that there were practice-specific, yet similar, time investments needed to report reliable monthly and yearly performance data. Although some informatics-related tasks were shared by Practices 2 and 4, the shared processes were mainly automated and performed outside of office hours; thus, they were not counted as employee time in our analyses. Interestingly, these automated data abstractions on just one performance measure were completed outside of office hours because they negatively affected the speed and functionality of the EHRs.

One standout cost for this practice was attributed to the large amount of time needed to identify patients at the point of care who had uncontrolled HTN (Table 2, Task 8). This activity was required for Practices 2 and 4, because the initial EHR data abstractions revealed very low numbers of patients with uncontrolled HTN. To identify patients in Practice 2, an office manager wrote down each person's point-of-care BP on the daily patient lists and faxed these lists to our research staff so they could review them for eligibility. During the first year of the study's implementation, this office manager devoted approximately 1.5 hours per day for 5 months, followed by 30 minutes per day for 7 months to this task, for an estimated total of 242 hours in employee time.

Practice 3

Practice 3 is a CHC that engaged in the early developmental and initial implementation phases of the project but did not find it feasible to participate in the regional meetings or monthly phone calls. The informatics staff was the most engaged and included an office administrator who worked with an off-site informatics consultant to abstract the practice's performance data and identify the patient population with uncontrolled HTN. This practice had nearly 100% provider turnover during the study but continued to refer patients over time. Thus, we included the tasks completed by the practice in our cost analyses.

Practice 4

Practice 4 is a private practice and, like Practices 2 and 3, is in a more rural region than Practice 1. This practice's lead provider participated in the monthly calls and attended the dinner meetings, but, in general, fewer—but highly effective—medical assistants and other staff members engaged in the study. Total costs for this practice in both the first and subsequent years of implementation were the lowest of all the practices. This practice had the highest percentage of patients with controlled BP; thus, it had the lowest number of patients requiring phone coaching services.

Maintenance Phase Cost Estimates

Our practice providers and HHL investigators agreed that maintaining QI work in practices required continued data abstractions, data review procedures, and participation in collaborative quarterly dinner meetings. We estimated the following maintenance costs for the practice activities: Practice 1, $2,795; Practice 2, $1,920; and Practice 4, $1,219 per year (Practice 3 was not included because it did not participate consistently in the QI project). We estimated additional coaching costs to be $44 per incident case of uncontrolled HTN.

DISCUSSION

We performed an activity-based costing analysis to estimate the costs of participating in an HTN QI project in rural primary care practices in an economically distressed region of the United States. Our results highlight the need for practices to invest in human resources to improve the identification and management of patients with HTN. Not unexpectedly, because the practices had little experience with population level data abstraction procedures, IT and clinical staff members needed to invest a substantial amount of time during the developmental phase of the project.

Most of the practice staff costs were devoted to attending on-site and regional meetings. Providing patient level health coaching was one of the greatest expenses and probably could be reduced if higher numbers of patients achieve controlled BPs.

Although the literature contains evaluations of costs associated with implementing HTN improvement strategies, most of these estimates focus on the societal level (Allen et al., 2014; Brunenberg et al., 2007; Chung et al., 2014; Reed et al., 2010) or focus on the costs of providing additional self-management support services (Kilpatrick et al., 2005). Direct comparisons to our study are limited because of methodological differences and length, frequency, and content of coaching calls with patients compared to practices used in other studies.

However, Reed et al. (2010) used the same basic phone coaching curriculum and HBPM that we used in our work. These authors performed a societal level economic analysis of the Take Care of Your Blood Pressure trial. The study used a 2-by-2 factorial design with patients randomized to one of four arms: (a) home BP monitoring alone, (b) nursing calls alone, (c) both home monitoring and nurse coaching, and (d) usual care. Taking the societal approach, the investigators included the costs of hospitalizations, outpatient visits, laboratory tests, and procedure costs, along with physician fees and costs incurred by patients receiving training in measuring home BP and in engaging in coaching calls. Per-patient cost for the combined intervention (i.e., nurse coaching and home monitoring) was $416 over 24 months and $1,157 when considering patients' time. When analyzed in light of BP reduction, Reed et al. (2010) estimated the 2-year cost per 1-point reduction in systolic BP to be $107 in direct medical costs and $297 when including the costs of patients' time. In the era of accountable care organizations and patient-centered approaches to care, analyses that include the costs incurred by all stakeholders and outcome data will be helpful when selecting strategies to implement at the health system level.

Study Limitations

Our study, like other QI studies, used a QI approach to practice change. This approach can impede the ability to tease out individual or combinations of effective strategies that are most worthy of financial investment. We did not perform a cost–benefit or cost-effectiveness analysis against our main outcome of BP reduction. We also did not have a control group.

Recall bias is a significant concern, but practice stakeholders unanimously expressed their desire to collect time estimates via interviews versus using activity logs or time-in-motion study methods. In an analysis comparing time-in-motion methods with self-reported activity time,

Burke et al. (2000) suggested that time-in-motion methods may provide greater accuracy but are hindered by social desirability bias that can occur when an observer is present. In addition, time-in-motion methods of evaluation are costlier. We had no way of determining whether interviewees systematically underestimated or overestimated their time investment, and thus, we cannot estimate the effect of this bias on the cost estimates.

Certainly, other primary care practices may have different numbers of patients with uncontrolled HTN and, consequently, could have markedly different total costs to consider when attempting to provide phone-based health coaching. Because of this limitation, we included a per-patient estimate to provide more helpful data to those interested in generating their own estimates.

To estimate the costs for a minimum number of practice staff members to attend each educational activity, we used actual attendance numbers and relied on the opinions of practice leaders. However, we have no way of knowing whether these estimates are accurate and if this information is generalizable to other practices. Some stakeholders may believe that other approaches to estimating cost may be more valuable, such as describing the costs per staff member instead of focusing on costs per task.

CONCLUSION

The time required to implement new HTN care activities and offer health coaching to those with uncontrolled HTN is not inconsequential but likely consistent with other efforts to improve care processes and patient outcomes in primary care practice. We hope that sharing our cost data from this HHL QI study will enable practice leaders, policymakers, patients, and other research teams to more accurately identify the potential resources needed and tasks required to make changes in HTN care delivery in primary care practice. Although we recognize the small scale of our work, activity-based costing methods to understand practice level costs may become more relevant as payment models shift toward value-based contracts and work to improve health systems. Exciting work supported by the U.S. Department of Health and Human Services' Transforming Clinical Practice Initiative (U.S. Department of Health and Human Services, 2015) may provide direction regarding the models of care delivery that are most likely to result in improved patient outcomes and experiences, while providing larger-scale analyses of the associated costs.

ACKNOWLEDGMENTS

Funding for this study was provided by the National, Heart, Lung, and Blood Institute (NHLBI 1P50HL10584-01). The funding body had no role in the collection, analysis, or interpretation of study data, nor did it play a role in writing the manuscript or submitting the manuscript for publication.

This cost analysis was presented as a poster at the AHRQ/NAPCRG Practice-Based Research Network Conference in Bethesda, MD, in June 2014.

REFERENCES

Allen, J. K., Dennison Himmelfarb, C. R., Szanton, S. L., & Frick, K. D. (2014). Cost-effectiveness of nurse practitioner/community health worker care to reduce cardiovascular health disparities. *Journal of Cardiovascular Nursing*, *29*(4), 308–314.

Barton, P., Andronis, L., Briggs, A., McPherson, K., & Capewell, S. (2011). Effectiveness and cost effectiveness of cardiovascular disease prevention in whole populations: Modeling study. *British Medical Journal*, *343*, d4044.

Bodenheimer, T., Wagner, E. H., & Grumbach, K. (2002). Improving primary care for patients with chronic illness. *Journal of the American Medical Association*, *288*(15), 1909–1914.

Bosworth, H. B., Olsen, M. K., Gentry, P., Orr, M., Dudley, T., McCant, F., & Oddone, E. Z. (2005). Nurse administered telephone intervention for blood pressure control: A patient-tailored multifactorial intervention. *Patient Education and Counseling*, *57*(1), 5–14.

Brunenberg, D. E., Wetzels, G. E., Nelemans, P. J., Dirksen, C. D., Severens, J. L., Stoffers, H. E., … Joore, M. A. (2007). Cost effectiveness of an adherence-improving programme in hypertensive patients. *Pharmacoeconomics*, *25*(3), 239–251.

Burke, T. A., McKee, J. R., Wilson, H. C., Donahue, R. M., Batenhorst, A. S., & Pathak, D. S. (2000). A comparison of time-and-motion and self-reporting methods of work measurement. *Journal of Nursing Administration*, *30*(3), 118–125.

Chung, O., Vongpatanasin, W., Bonaventura, K., Lotan, Y., Sohns, C., Haverkamp, W., & Dorenkamp, M. (2014). Potential cost-effectiveness of therapeutic drug monitoring in patients with resistant hypertension. *Journal of Hypertension*, *32*(12), 2411–2421.

DeWalt, D. A., Pignone, M., Malone, R., Rawls, C., Kosnar, M. C., George, G., … Angel, B. (2004). Development and pilot testing of a disease management program for low literacy patients with heart failure. *Patient Education and Counseling*, *55*(1), 78–86.

Donahue, K. E., Halladay, J. R., Wise, A., Reiter, K., Lee, S. Y., Ward, K., … Qaqish, B. (2013). Facilitators of primary care transformation: A look under the hood at leadership. *Annals of Family Medicine*, *11*(Suppl. 1), S27–S33.

Donahue, K. E., Newton, W. P., Lefebvre, A., & Plescia, M. (2013). The natural history of practice transformation: Development and initial testing of an outcomes based model. *Annals of Family Medicine*, *11*(3), 212–219.

Estruch, R., Martínez-González, M. A., Corella, D., Salas-Salvadó, J., Ruiz-Gutiérrez, V., Covas, M. I., … PREDIMED Study Investigators. (2006). Effects of a Mediterranean-style diet on cardiovascular risk factors: A randomized trial. *Annals of Internal Medicine*, *145*(1), 1–11.

Estruch, R., Ros, E., Salas-Salvadó, J., Covas, M. I., Corella, D., Arós, F., … PREDIMED Study Investigators. (2013). Primary prevention of cardiovascular disease with a Mediterranean diet. *New England Journal of Medicine*, *368*(14), 1279–1290.

Finkelstein, E. A., Khavjou, O., & Will, J. C. (2006). Cost-effectiveness of WISEWOMAN, a program aimed at reducing heart disease risk among low-income women. *Journal of Women's Health*, *15*(4), 379–389.

Finkelstein, E. A., Wittenborn, J. S., & Farris, R. P. (2004). Evaluation of public health demonstration programs: The effectiveness and cost-effectiveness of WISEWOMAN. *Journal of Women's Health*, *13*(5), 625–633.

Halladay, J. R., DeWalt, D. A., Wise, A., Qaqish, B., Reiter, K., Lee, S. Y., … Donahue, K. E. (2014). More extensive implementation of elements of the Chronic Care Model are associated with better clinical outcomes in diabetes. *Journal of the American Board of Family Medicine*, *27*(1), 34–41.

Halladay, J. R., Donahue, K. E., Hinderliter, A. L., Cummings, D. M., Cene, C. W., Miller, C. L., … Heart Healthy Lenoir Research Team. (2013). The Heart Healthy Lenoir project—An intervention to reduce disparities in hypertension control: Study protocol. *BMC Health Services Research*, *13*, 441. doi: 10.1186/1472-6963-13-441

Heidenreich, P. A., Trogdon, J. G., Khavjou, O. A., Butler, J., Dracup, K., Ezekowitz, M. D., … Interdisciplinary Council on Quality of Care and Outcomes Research. (2011). Forecasting the future of cardiovascular disease in the United States: A policy statement from the American Heart Association. *Circulation*, *123*(8), 933–944.

Hollenback, C. S., Weiner, M. G., & Turner, B. J. (2014). Cost-effectiveness of a peer and practice staff support intervention. *American Journal of Managed Care*, *20*(3), 253–260.

Keyserling, T. C., Sheridan, S. L., Draeger, L. B., Finkelstein, E. A., Gizlice, Z., Kruger, E., … Ammerman, A. S. (2014). A comparison of live counseling with a Web-based lifestyle and medication intervention to reduce coronary heart disease risk: A randomized clinical trial. *JAMA Internal Medicine*, *174*(7), 1144–1157.

Kilpatrick, K. E., Lohr, K. N., Leatherman, S., Pink, G., Buckel, J. M., Legarde, C., & Whitener, L. (2005). The insufficiency of evidence to establish the business case for quality. *International Journal for Quality in Health Care*, *17*(4), 347–355.

Margolis, P. A., DeWalt, D. A., Simon, J. E., Horowitz, S., Scoville, R., Kahn, N., … Miles, P. (2010). Designing a large-scale multilevel

improvement initiative: The improving performance in practice program. *Journal of Continuing Education in the Health Professions*, *30*(3), 187–196.

Mueller, M., Purnell, T. S., Mensah, G. A., & Cooper, L. A. (2015). Reducing racial and ethnic disparities in hypertension prevention and control: What will it take to translate research into practice and policy? *American Journal of Hypertension*, *28*(6), 699–716. doi:10.1093/ajh/hpu233

National Center for Health Statistics. (2013). *Health, United States, 2012: With special feature on emergency care*. Retrieved from www.cdc.gov/nchs/data/hus/hus12.pdf

North Carolina Department of Commerce. (2015). *County tier designations*. Retrieved from www.nccommerce.com/research-publications/incentive-reports/county-tier-designations

Pittman, D. G., Tao, Z., Chen, W., & Stettin, G. D. (2010). Antihypertensive medication adherence and subsequent healthcare utilization costs. *American Journal of Managed Care*, *16*(8), 568–576.

Reed, S. D., Li, Y., Oddone, E. Z., Neary, A. M., Orr, M. M., Grubber, J. M., … Bosworth, H. B. (2010). Economic evaluation of home blood pressure monitoring with or without telephonic behavioral self-management in patients with hypertension. *American Journal of Hypertension*, *23*(2), 142–148.

Rothman, R. L., Malone, R., Bryant, B., Shintani, A. K., Crigler, B., Dewalt, D. A., … Pignone, M. P. (2005). A randomized trial of a primary care-based, disease management program to improve cardiovascular risk factors and glycated hemoglobin in patients with diabetes. *American Journal of Medicine*, *118*(3), 276–284.

Schroeder, K., Fahey, T., Hollinghurst, S., & Peters, T. J. (2005). Nurse-led adherence support in hypertension: A randomized controlled trial. *Journal of Family Practice*, *22*(2), 144–151.

Shojania, K. G., McDonald, K. M., Wachter, R. M., & Owens, D. K. (Eds.). (2004). *Closing the quality gap: A critical analysis of quality improvement strategies (Vol. 1: Series overview and methodology)*. Retrieved from www.ahrq.gov/sites/default/files/wysiwyg/research/findings/evidence-based-reports/qualgap1.pdf

U.S. Bureau of Labor Statistics. (2010, May 20). *National compensation survey: Occupational earnings in the United States* (Bulletin 2753). Retrieved from www.bls.gov/ncs/ncwage2010.htm

U.S. Department of Health and Human Services. (2015). *Transforming clinical practice initiative*. Retrieved from https://innovation.cms.gov/initiatives/Transforming-Clinical-Practices/

Wagner, E. H., Austin, B. T., & Von Korff, M. (1996). Organizing care for patients with chronic illness. *Milbank Quarterly*, *74*(4), 511–544.

Walsh, J. M., McDonald, K. M., Shojania, K. G., Sundaram, V., Nayak, S., Lewis, R., … Goldstein, M. K. (2006). Quality improvement strategies for hypertension management: A systematic review. *Medical Care*, *44*(7), 646–657.